Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

Let $AD=a=29$, $BC=q=32$, $CD=c=40$, $DA=d=36$, $AC=BD=x$, $\angle DOA=\theta$. Project AD, BC, AC on BD.

$\therefore$ $x=d\cos ADB+b\cos CBD+x\cos\theta$. Multiply through by $2x$ and write, $-\cos(ADB+CAD)$ for $\cos\theta$.

$\therefore$ $2x^2=2dx\cos ADB+2bx\cos CBK-2x^2\cos(ADB+CAK)$; $2dx\cos AKB=d^2+x^2-a^2$; $2bx\cos CBK=d^2+x^2-c^2=2dx\cos CAK$. Substituting,

$$2x^2=d^2+x^2-a^2+d^2+x^2-c^2-1/2d^2(d^2+x^2-a^2)(d^2+x^2-c^2)$$
$$+1/2d^2\sqrt{\{[4d^2x^2-(d^2+x^2-a^2)^2][4d^2x^2-(d^2+x^2-c^2)^2]\}}.$$

Reducing and collecting,

$$2x^6-(a^2+b^2+c^2+d^2)x^4+[a^2(b^2-2c^2+d^2)+b^2(c^2-2d^2)+c^2d^2]x^2$$
$$+(ac-bd)(ac+bd)(a^2-b^2+c^2-d^2)=0.$$

Restoring numbers, $2x^6-4761x^4+317712x^2+2238016=0$.

$\therefore$ $x=48.07$ nearly.

Also solved by *LON C. WALKER*, *J. SCHEFFER*, and *D. B. NORTHRUP*. Mr. Northrup's result agreed with Professor Zerr's and was obtained by the method of trial and error.

129. Proposed by J. SCHEFFER, A. M., Hagerstown, Md.

How high above the surface of the earth must an observer be elevated at the latitude $\phi(=39°\ 19')$, the declination of the sun being $\delta(=23°\ 27')$, in order to see the sun at midnight?

Solution by the PROPOSER.

The sun will be seen at midnight when the tangent drawn from the point to the earth strikes the sun when on the meridian at midnight. Denoting the required height above the earth by h, the radius of the earth by R, the latitude of the place by ϕ, and the declination of the sun by δ, we easily find $\sin(\phi+\delta)=\frac{R}{R+h}$, whence $h=\frac{R[1-\sin(\phi+\delta)]}{\sin(\phi+\delta)}=\frac{2R\sin^2[45-\frac{1}{2}(\phi+\delta)]}{\sin(\phi+\delta)}$.

For $\phi=39°\ 19'$, $\delta=23°\ 27'$, we get $h=495$ miles, nearly.

Also solved, with slightly different results, by *G. B. M. ZERR*, *S. HART WRIGHT*, and *G. W. GREENWOOD*.